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Πίνακας περιεχομένων

[1 Ecology 1-3](#_Toc509423871)

[1.1 Levels, scope, and scale of organization 1-3](#_Toc509423872)

[1.2 Hierarchy 1-3](#_Toc509423873)

[1.3 Biodiversity 1-3](#_Toc509423874)

[1.4 Habitat 1-4](#_Toc509423875)

[2 Conservation biology 5](#_Toc509423876)

[2.1 Origins 5](#_Toc509423877)

[2.2 Description 5](#_Toc509423878)

[2.3 History 6](#_Toc509423879)

[3 Ecosystem 7](#_Toc509423880)

[3.1 Definition 7](#_Toc509423881)

[3.2 Processes 7](#_Toc509423882)

[4 Environment (biophysical) 9](#_Toc509423883)

[4.1 Life-environment interaction 9](#_Toc509423884)

[4.2 Related studies 9](#_Toc509423885)

[5 Theoretical ecology 11](#_Toc509423886)

[5.1 Neutral theory 11](#_Toc509423887)

[5.2 Biogeography 11](#_Toc509423888)

[5.3 Ecosystem ecology 11](#_Toc509423889)

[6 Η οικογένειά μου 13](#_Toc509423890)

# Ecology

## Levels, scope, and scale of organization

The scope of ecology contains a broad array of bionomical levels of organization spanning micro-level (e.g., cells) to a global scale (e.g., biosphere) phenomena. Ecosystems, for example, contain abiotic resources and interacting life forms (i.e., individual organisms that aggregate into populations which aggregate into clear ecological communities). Ecosystems are dynamic, they do not always follow a linear successional path, but they are always changing, sometimes rapidly and sometimes so slowly that it can take thousands of years for ecological processes to bring about certain successional stages of a forest. An ecosystem's area can vary greatly, from tiny to vast. A single tree is of little consequence to the classification of a forest ecosystem, but critically relevant to organisms living in and on it.[3] Several generations of an aphid population can exist over the lifespan of a single leaf. Each of those aphids, in turn, support diverse bacterial communities.[4] The nature of connections in ecological communities cannot be explained by knowing the details of each species in isolation, because the emergent pattern is neither revealed nor predicted until the ecosystem is studied as an integrated whole.[5] Some ecological principles, however, do exhibit collective properties where the sum of the components explain the properties of the whole, such as birth rates of a population being equal to the sum of individual births over a designated time frame.[6]

## Hierarchy

The scale of ecological dynamics can operate like a closed system, such as aphids migrating on a single tree, while at the same time remain open with regard to broader scale influences, such as atmosphere or climate. Hence, ecologists classify [ecosystems](https://en.wikipedia.org/wiki/Ecosystems" \o "Ecosystems) hierarchically by analyzing data collected from finer scale units, such as vegetation associations, climate, and soil types, and integrate this information to identify emergent patterns of uniform organization and processes that operate on local to regional, [landscape](https://en.wikipedia.org/wiki/Landscape" \o "Landscape), and chronological scales.

To structure the study of ecology into a conceptually manageable framework, the biological world is organized into a [nested hierarchy](https://en.wikipedia.org/wiki/Biological_classification), ranging in scale from [genes](https://en.wikipedia.org/wiki/Gene), to [cells](https://en.wikipedia.org/wiki/Cell_(biology)), to [tissues](https://en.wikipedia.org/wiki/Tissue_(biology)), to [organs](https://en.wikipedia.org/wiki/Organ_(anatomy)), to [organisms](https://en.wikipedia.org/wiki/Organism), to [species](https://en.wikipedia.org/wiki/Species), to [populations](https://en.wikipedia.org/wiki/Population_ecology), to [communities](https://en.wikipedia.org/wiki/Community_(ecology)), to [ecosystems](https://en.wikipedia.org/wiki/Ecosystem), to [biomes](https://en.wikipedia.org/wiki/Biome), and up to the level of the [biosphere](https://en.wikipedia.org/wiki/Biosphere).[[8]](https://en.wikipedia.org/wiki/Ecology#cite_note-Nachtomy01-8) This framework forms a [panarchy](https://en.wikipedia.org/wiki/Panarchy" \o "Panarchy)[[9]](https://en.wikipedia.org/wiki/Ecology#cite_note-Holling01-9) and exhibits [non-linear](https://en.wikipedia.org/wiki/Non-linear) behaviors; this means that "effect and cause are disproportionate, so that small changes to critical variables, such as the number of [nitrogen fixers](https://en.wikipedia.org/wiki/Nitrogen_fixation), can lead to disproportionate, perhaps irreversible, changes in the system properties."[[10]](https://en.wikipedia.org/wiki/Ecology#cite_note-Levin99-10):14

## Biodiversity

Biodiversity (an abbreviation of "biological diversity") describes the diversity of life from genes to ecosystems and spans every level of biological organization. The term has several interpretations, and there are many ways to index, measure, characterize, and represent its complex organization.[12][13][14] Biodiversity includes species diversity, ecosystem diversity, and genetic diversity and scientists are interested in the way that this diversity affects the complex ecological processes operating at and among these respective levels.[13][15][16] Biodiversity plays an important role in ecosystem services which by definition maintain and improve human quality of life.[14][17][18] Conservation priorities and management techniques require different approaches and considerations to address the full ecological scope of biodiversity. Natural capital that supports populations is critical for maintaining ecosystem services[19][20] and species migration (e.g., riverine fish runs and avian insect control) has been implicated as one mechanism by which those service losses are experienced.[21] An understanding of biodiversity has practical applications for species and ecosystem-level conservation planners as they make management recommendations to consulting firms, governments, and industry.[22]

## Habitat

The habitat of a species describes the environment over which a species is known to occur and the type of community that is formed as a result.[24] More specifically, "habitats can be defined as regions in environmental space that are composed of multiple dimensions, each representing a biotic or abiotic environmental variable; that is, any component or characteristic of the environment related directly (e.g. forage biomass and quality) or indirectly (e.g. elevation) to the use of a location by the animal."[25]:745 For example, a habitat might be an aquatic or terrestrial environment that can be further categorized as a montane or alpine ecosystem. Habitat shifts provide important evidence of competition in nature where one population changes relative to the habitats that most other individuals of the species occupy. For example, one population of a species of tropical lizards (Tropidurus hispidus) has a flattened body relative to the main populations that live in open savanna. The population that lives in an isolated rock outcrop hides in crevasses where its flattened body offers a selective advantage. Habitat shifts also occur in the developmental life history of amphibians, and in insects that transition from aquatic to terrestrial habitats. Biotope and habitat are sometimes used interchangeably, but the former applies to a community's environment, whereas the latter applies to a species' environment.[24][26][27]

# Conservation biology

## Origins

The term conservation biology and its conception as a new field originated with the convening of "The First International Conference on Research in Conservation Biology" held at the University of California, San Diego in La Jolla, California in 1978 led by American biologists Bruce A. Wilcox and Michael E. Soulé with a group of leading university and zoo researchers and conservationists including Kurt Benirschke, Sir Otto Frankel, Thomas Lovejoy, and Jared Diamond. The meeting was prompted by the concern over tropical deforestation, disappearing species, eroding genetic diversity within species.[8] The conference and proceedings that resulted[2] sought to initiate the bridging of a gap between theory in ecology and evolutionary genetics on the one hand and conservation policy and practice on the other.[9] Conservation biology and the concept of biological diversity (biodiversity) emerged together, helping crystallize the modern era of conservation science and policy. The inherent multidisciplinary basis for conservation biology has led to new subdisciplines including conservation social science, conservation behavior and conservation physiology.[10] It stimulated further development of conservation genetics which Otto Frankel had originated first but is now often considered a subdiscipline as well.

## Description

The rapid decline of established biological systems around the world means that conservation biology is often referred to as a "Discipline with a deadline".[[11]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-11) Conservation biology is tied closely to [ecology](https://en.wikipedia.org/wiki/Ecology) in researching the [population ecology](https://en.wikipedia.org/wiki/Population_ecology) ([dispersal](https://en.wikipedia.org/wiki/Biological_dispersal), [migration](https://en.wiktionary.org/wiki/migration), [demographics](https://en.wikipedia.org/wiki/Demographics), [effective population size](https://en.wikipedia.org/wiki/Effective_population_size), [inbreeding depression](https://en.wikipedia.org/wiki/Inbreeding_depression), and [minimum population viability](https://en.wikipedia.org/wiki/Minimum_viable_population)) of [rare](https://en.wikipedia.org/wiki/Rare_species) or [endangered species](https://en.wikipedia.org/wiki/Endangered_species).[[12]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-12)[[13]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-SahneyBentonFerry2010LinksDiversityVertebrates-13) Conservation biology is concerned with phenomena that affect the maintenance, loss, and restoration of biodiversity and the science of sustaining evolutionary processes that engender [genetic](https://en.wikipedia.org/wiki/Genetics), [population](https://en.wikipedia.org/wiki/Population), [species](https://en.wikipedia.org/wiki/Species), and ecosystem diversity.[[5]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Hunter96-5)[[6]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Groom06-6)[[7]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Dyke08-7)[[13]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-SahneyBentonFerry2010LinksDiversityVertebrates-13) The concern stems from estimates suggesting that up to 50% of all species on the planet will disappear within the next 50 years,[[14]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Koh-14) which has contributed to poverty, starvation, and will reset the course of evolution on this planet.[[15]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-15)[[16]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Jackson-16)

Conservation biologists research and educate on the trends and process of [biodiversity loss](https://en.wikipedia.org/wiki/Biodiversity_loss), species [extinctions](https://en.wikipedia.org/wiki/Extinction), and the negative effect these are having on our capabilities to [sustain](https://en.wikipedia.org/wiki/Sustainability) the well-being of human society. Conservation biologists work in the field and office, in government, universities, non-profit organizations and industry. The topics of their research are diverse, because this is an interdisciplinary network with professional alliances in the biological as well as social sciences. Those dedicated to the cause and profession [advocate](https://en.wikipedia.org/wiki/Advocate) for a global response to [the current biodiversity crisis](https://en.wikipedia.org/wiki/Holocene_extinction) based on [morals](https://en.wikipedia.org/wiki/Morals), [ethics](https://en.wikipedia.org/wiki/Ethics), and scientific [reason](https://en.wikipedia.org/wiki/Reason). Organizations and citizens are responding to the biodiversity crisis through conservation action plans that direct research, monitoring, and education programs that engage concerns at local through global scales.[[4]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Soule86-4)[[5]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Hunter96-5)[[6]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Groom06-6)[[7]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Dyke08-7)

## History

Conscious efforts to conserve and protect global biodiversity are a recent phenomenon.[[7]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Dyke08-7)[[18]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-18) Natural resource conservation, however, has a history that extends prior to the age of conservation. Resource ethics grew out of necessity through direct relations with nature. Regulation or communal restraint became necessary to prevent selfish motives from taking more than could be locally sustained, therefore compromising the long-term supply for the rest of the community.[[7]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Dyke08-7) This social dilemma with respect to natural resource management is often called the "[Tragedy of the Commons](https://en.wikipedia.org/wiki/Tragedy_of_the_Commons)".[[19]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-19)[[20]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-20)

From this principle, conservation biologists can trace communal resource based ethics throughout cultures as a solution to communal resource conflict.[[7]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Dyke08-7) For example, the Alaskan [Tlingit](https://en.wikipedia.org/wiki/Tlingit_people) peoples and the [Haida](https://en.wikipedia.org/wiki/Haida_people" \o "Haida people) of the [Pacific Northwest](https://en.wikipedia.org/wiki/Pacific_Northwest) had resource boundaries, rules, and restrictions among clans with respect to the fishing of [sockeye salmon](https://en.wikipedia.org/wiki/Sockeye_salmon). These rules were guided by clan elders who knew lifelong details of each river and stream they managed.[[7]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Dyke08-7)[[21]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-Mason-21) There are numerous examples in history where cultures have followed rules, rituals, and organized practice with respect to communal natural resource management.[[22]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-22)[[23]](https://en.wikipedia.org/wiki/Conservation_biology#cite_note-23)

# Ecosystem

## Definition

There is no single definition of what constitutes an ecosystem.[[3]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Sagoff2003-3) German ecologist Ernst-Detlef Schulze and coauthors defined an ecosystem as an area which is "uniform regarding the biological turnover, and contains all the fluxes above and below the ground area under consideration." They explicitly reject [Gene Likens](https://en.wikipedia.org/wiki/Gene_Likens)' use of entire [river catchments](https://en.wikipedia.org/wiki/Drainage_basin) as "too wide a demarcation" to be a single ecosystem, given the level of heterogeneity within such an area.[[11]](https://en.wikipedia.org/wiki/Ecosystem" \l "cite_note-Schulze399-11) Other authors have suggested that an ecosystem can encompass a much larger area, even the whole planet.[[7]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-planet-7) Schulze and coauthors also rejected the idea that a single rotting log could be studied as an ecosystem because the size of the flows between the log and its surroundings are too large, relative to the proportion cycles within the log.[[11]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Schulze399-11) Philosopher of science Mark Sagoff considers the failure to define "the kind of object it studies" to be an obstacle to the development of theory in [ecosystem ecology](https://en.wikipedia.org/wiki/Ecosystem_ecology" \o "Ecosystem ecology).[[3]](https://en.wikipedia.org/wiki/Ecosystem" \l "cite_note-Sagoff2003-3)

Ecosystems can be studied through a variety of approaches—theoretical studies, studies monitoring specific ecosystems over long periods of time, those that look at differences between ecosystems to elucidate how they work and direct manipulative experimentation.[[12]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Carpenter1998-12) Studies can be carried out at a variety of scales, from [microcosms](https://en.wikipedia.org/wiki/Microcosm:_Model_/_experimental_ecosystem) and [mesocosms](https://en.wikipedia.org/wiki/Mesocosm" \o "Mesocosm) which serve as simplified representations of ecosystems, through whole-ecosystem studies.[[13]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Schindler1998-13) American ecologist [Stephen R. Carpenter](https://en.wikipedia.org/wiki/Stephen_R._Carpenter) has argued that microcosm experiments can be "irrelevant and diversionary" if they are not carried out in conjunction with field studies carried out at the ecosystem scale, because microcosm experiments often fail to accurately predict ecosystem-level dynamics.[[14]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Carpenter1996-14)

The [Hubbard Brook Ecosystem Study](https://en.wikipedia.org/wiki/Hubbard_Brook_Ecosystem_Study), established in the [White Mountains, New Hampshire](https://en.wikipedia.org/wiki/White_Mountains_(New_Hampshire)) in 1963, was the first successful attempt to study an entire [watershed](https://en.wikipedia.org/wiki/Watershed_management) as an ecosystem. The study used stream [chemistry](https://en.wikipedia.org/wiki/Chemistry) as a means of monitoring ecosystem properties, and developed a detailed [biogeochemical model](https://en.wikipedia.org/wiki/Biogeochemistry) of the ecosystem.[[15]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Lindenmayer2010-15) [Long-term research](https://en.wikipedia.org/wiki/Long_Term_Ecological_Research_Network) at the site led to the discovery of [acid rain](https://en.wikipedia.org/wiki/Acid_rain) in North America in 1972, and was able to document the consequent depletion of soil [cations](https://en.wikipedia.org/wiki/Cations" \o "Cations) (especially calcium) over the next several decades.[[16]](https://en.wikipedia.org/wiki/Ecosystem#cite_note-Likens2004-16)

## Processes

Ecosystems are controlled both by external and internal factors. External factors, also called state factors, control the overall structure of an ecosystem and the way things work within it, but are not themselves influenced by the ecosystem. The most important of these is [climate](https://en.wikipedia.org/wiki/Climate" \o "Climate).[[9]](https://en.wikipedia.org/wiki/Ecosystem" \l "cite_note-Chapin11-9) Climate determines the [biome](https://en.wikipedia.org/wiki/Biome" \o "Biome) in which the ecosystem is embedded. Rainfall patterns and temperature seasonality determine the amount of water available to the ecosystem and the supply of energy available (by influencing photosynthesis).[[9]](https://en.wikipedia.org/wiki/Ecosystem" \l "cite_note-Chapin11-9)

[Parent material](https://en.wikipedia.org/wiki/Parent_material" \o "Parent material), the underlying geological material that gives rise to soils, determines the nature of the soils present, and influences the supply of mineral nutrients. [Topography](https://en.wikipedia.org/wiki/Topography" \o "Topography) also controls ecosystem processes by affecting things like [microclimate](https://en.wikipedia.org/wiki/Microclimate" \o "Microclimate), soil development and the movement of water through a system. This may be the difference between the ecosystem present in [wetland](https://en.wikipedia.org/wiki/Wetland" \o "Wetland) situated in a small depression on the landscape, and one present on an adjacent steep hillside.[[9]](https://en.wikipedia.org/wiki/Ecosystem" \l "cite_note-Chapin11-9)

Complex Table (less accessible)

**Class Schedule**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| LESSON | TOPIC | ASSIGNMENT | Points | DUE |
| 1 | What is Distance Learning? | Wiki #1 | 10 | March 10 |
| Presentation | 20 |  |
| 2 | History & Theories | Brief Paper | 20 | March 24 |
| Spring Break | | | | |
| 3 | Distance  Learners | Discussion #1 | 10 | April 7 |
| Group Project | 50 | April 14 |
| 4 | Media Selection | Blog #1 | 10 | April 21 |

# Environment (biophysical)



The biophysical environment is the [biotic](https://en.wikipedia.org/wiki/Life) and [abiotic](https://en.wikipedia.org/wiki/Abiotic_component" \o "Abiotic component) surrounding of an [organism](https://en.wikipedia.org/wiki/Organism) or [population](https://en.wikipedia.org/wiki/Population), and consequently includes the factors that have an influence in their survival, development, and evolution.[[1]](https://en.wikipedia.org/wiki/Environment_(biophysical)#cite_note-1) The biophysical environment can vary in scale from [microscopic](https://en.wikipedia.org/wiki/Microscopic) to global in extent. It can also be subdivided according to its attributes. Examples include the [marine environment](https://en.wikipedia.org/wiki/Marine_environment" \o "Marine environment), the [atmospheric environment](https://en.wikipedia.org/wiki/Atmospheric_environment" \o "Atmospheric environment) and the [terrestrial environment](https://en.wikipedia.org/wiki/Ecoregion" \l "Terrestrial" \o "Ecoregion).[[2]](https://en.wikipedia.org/wiki/Environment_(biophysical)" \l "cite_note-2) The number of biophysical environments is countless, given that each living organism has its own environment.

The term [environment](https://en.wiktionary.org/wiki/environment" \o "wikt:environment) is often used as a short form for the biophysical environment, e.g. the UK's [Environment Agency](https://en.wikipedia.org/wiki/Environment_Agency" \o "Environment Agency). The expression "the environment" often refers to a singular global environment in relation to humanity.

## Life-environment interaction

All life that has survived must have adapted to conditions of its environment. Temperature, light, humidity, soil nutrients, etc., all influence any species, within any environment. However life in turn modifies, in various forms, its conditions. Some long term modifications along the history of our planet have been significant, such as the incorporation of oxygen to the atmosphere. This process consisted in the breakdown of carbon dioxide by anaerobic microorganisms that used the carbon in their metabolism and released the oxygen to the atmosphere. This led to the existence of oxygen-based plant and animal life, the great oxygenation event. Other interactions are more immediate and simple, such as the smoothing effect that forests have on the temperature cycle, compared to neighboring unforested areas.[citation needed]

## Related studies

[Environmental science](https://en.wikipedia.org/wiki/Environmental_science) is the study of the interactions within the biophysical environment. Part of this [scientific discipline](https://en.wikipedia.org/wiki/Branches_of_science) is the investigation of the [effect of human activity on the environment](https://en.wikipedia.org/wiki/Effect_of_human_activity_on_the_environment). [Ecology](https://en.wikipedia.org/wiki/Ecology), a sub-discipline of biology and a part of environmental sciences, is often mistaken as a study of human induced effects on the environment. [Environmental studies](https://en.wikipedia.org/wiki/Environmental_studies) is a broader [academic discipline](https://en.wikipedia.org/wiki/Academic_discipline) that is the systematic study of interaction of humans with their environment. It is a broad field of study that includes the [natural environment](https://en.wikipedia.org/wiki/Natural_environment" \o "Natural environment), [built environments](https://en.wikipedia.org/wiki/Built_environment" \o "Built environment) and [social environments](https://en.wikipedia.org/wiki/Social_environment" \o "Social environment).

Environmentalism is a broad social and philosophical movement that, in a large part, seeks to minimise and compensate the negative effect of human activity on the biophysical environment. The issues of concern for environmentalists usually relate to the natural environment with the more important ones being [climate change](https://en.wikipedia.org/wiki/Climate_change" \o "Climate change), [species](https://en.wikipedia.org/wiki/Species" \o "Species) [extinction](https://en.wikipedia.org/wiki/Extinction" \o "Extinction), [pollution](https://en.wikipedia.org/wiki/Pollution" \o "Pollution), and [old growth forest](https://en.wikipedia.org/wiki/Old_growth_forest" \o "Old growth forest) loss.

# Theoretical ecology

## Neutral theory

[Unified neutral theory](https://en.wikipedia.org/wiki/Unified_neutral_theory_of_biodiversity) is a hypothesis proposed by [Stephen Hubbell](https://en.wikipedia.org/wiki/Stephen_Hubbell) in 2001.[[20]](https://en.wikipedia.org/wiki/Theoretical_ecology#cite_note-Hubbell2001-20) The hypothesis aims to explain the diversity and relative abundance of species in ecological communities, although like other [neutral theories](https://en.wikipedia.org/wiki/Unified_neutral_theory_of_biodiversity) in ecology, Hubbell's hypothesis assumes that the differences between members of an ecological community of trophically similar species are "neutral," or irrelevant to their success. Neutrality means that at a given [trophic level](https://en.wikipedia.org/wiki/Trophic_level" \o "Trophic level) in a [food web](https://en.wikipedia.org/wiki/Food_web), species are equivalent in birth rates, death rates, dispersal rates and speciation rates, when measured on a per-capita basis.[[34]](https://en.wikipedia.org/wiki/Theoretical_ecology#cite_note-Hubbell2005-34) This implies that biodiversity arises at random, as each species follows a [random walk](https://en.wikipedia.org/wiki/Random_walk).[[35]](https://en.wikipedia.org/wiki/Theoretical_ecology#cite_note-McGill2003-35) This can be considered a [null hypothesis](https://en.wikipedia.org/wiki/Null_hypothesis" \o "Null hypothesis) to [niche theory](https://en.wikipedia.org/wiki/Ecological_niche" \o "Ecological niche). The hypothesis has sparked controversy, and some authors consider it a more complex version of other null models that fit the data better.

Under unified neutral theory, complex ecological interactions are permitted among individuals of an [ecological community](https://en.wikipedia.org/wiki/Ecological_community) (such as competition and cooperation), providing all individuals obey the same rules. Asymmetric phenomena such as [parasitism](https://en.wikipedia.org/wiki/Parasite) and [predation](https://en.wikipedia.org/wiki/Predator) are ruled out by the terms of reference; but cooperative strategies such as [swarming](https://en.wikipedia.org/wiki/Swarming), and negative interaction such as competing for limited food or light are allowed, so long as all individuals behave the same way. The theory makes predictions that have implications for the management of [biodiversity](https://en.wikipedia.org/wiki/Biodiversity), especially the management of rare species. It predicts the existence of a fundamental biodiversity constant, conventionally written θ, that appears to govern species richness on a wide variety of spatial and temporal scales.

## Biogeography

Biogeography is most keenly observed on islands, which has led to the development of the subdiscipline of [island biogeography](https://en.wikipedia.org/wiki/Island_biogeography). These habitats are often a more manageable areas of study because they are more condensed than larger ecosystems on the mainland. In 1967, [Robert MacArthur](https://en.wikipedia.org/wiki/Robert_MacArthur" \o "Robert MacArthur) and [E.O. Wilson](https://en.wikipedia.org/wiki/Edward_Osborne_Wilson" \o "Edward Osborne Wilson) published [The Theory of Island Biogeography](https://en.wikipedia.org/wiki/The_Theory_of_Island_Biogeography" \o "The Theory of Island Biogeography). This showed that the species richness in an area could be predicted in terms of factors such as habitat area, immigration rate and extinction rate.[[36]](https://en.wikipedia.org/wiki/Theoretical_ecology" \l "cite_note-36) The theory is considered one of the fundamentals of ecological theory.[[37]](https://en.wikipedia.org/wiki/Theoretical_ecology" \l "cite_note-Wiens04-37) The application of island biogeography theory to [habitat fragments](https://en.wikipedia.org/wiki/Habitat_fragmentation" \o "Habitat fragmentation) spurred the development of the fields of [conservation biology](https://en.wikipedia.org/wiki/Conservation_biology" \o "Conservation biology) and [landscape ecology](https://en.wikipedia.org/wiki/Landscape_ecology" \o "Landscape ecology).[[38]](https://en.wikipedia.org/wiki/Theoretical_ecology" \l "cite_note-38)

## Ecosystem ecology

Introducing new elements, whether [biotic](https://en.wikipedia.org/wiki/Biotic_component) or [abiotic](https://en.wikipedia.org/wiki/Abiotic" \o "Abiotic), into [ecosystems](https://en.wikipedia.org/wiki/Ecosystem) can be disruptive. In some cases, it leads to [ecological collapse](https://en.wikipedia.org/wiki/Ecological_collapse), [trophic cascades](https://en.wikipedia.org/wiki/Trophic_cascade" \o "Trophic cascade) and the death of many species within the ecosystem. The abstract notion of [ecological health](https://en.wikipedia.org/wiki/Ecological_health) attempts to measure the robustness and recovery capacity for an ecosystem; i.e. how far the ecosystem is away from its steady state. Often, however, ecosystems rebound from a disruptive agent. The difference between collapse or rebound depends on the [toxicity](https://en.wikipedia.org/wiki/Toxicity) of the introduced element and the [resiliency](https://en.wikipedia.org/wiki/Resilience_(ecology)) of the original ecosystem.

If ecosystems are governed primarily by [stochastic](https://en.wikipedia.org/wiki/Stochastic) processes, through which its subsequent state would be determined by both predictable and random actions, they may be more resilient to sudden change than each species individually. In the absence of a [balance of nature](https://en.wikipedia.org/wiki/Balance_of_nature), the species composition of ecosystems would undergo shifts that would depend on the nature of the change, but entire ecological collapse would probably be infrequent events. In 1997, [Robert Ulanowicz](https://en.wikipedia.org/wiki/Robert_Ulanowicz) used [information theory](https://en.wikipedia.org/wiki/Information_theory) tools to describe the structure of ecosystems, emphasizing [mutual information](https://en.wikipedia.org/wiki/Mutual_information) (correlations) in studied systems. Drawing on this methodology and prior observations of complex ecosystems, Ulanowicz depicts approaches to determining the stress levels on ecosystems and predicting system reactions to defined types of alteration in their settings (such as increased or reduced energy flow, and [eutrophication](https://en.wikipedia.org/wiki/Eutrophication" \o "Eutrophication).[[47]](https://en.wikipedia.org/wiki/Theoretical_ecology#cite_note-47)

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